were not frozen, to be quite active. I have taken the common newt on several occasions in damp woods, under logs, when they appear to be frozen, but when placed in the sun or held in the hand a short time would revive. Early in March the woodland ponds of this vicinity teem with salamanders of different species.

In this part of the Ohio valley, as a rule, tortoises, turtles, toads and frogs are found hibernating; on the other hand the newts, salamanders and many species of fish do not enter a torpid state.

Exceptions to these rules will doubtless occasionally be noticed, but from the present state of our knowledge of the life-histories of these animals they hold good.

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THE AMBLYPODA.

BY E. D. COPE.

(Continued from page 1202, Vol. xviii.)

DINOCERATA.

IN this suborder we have a series of mammals which are in some respects the most remarkable that have ever existed. This is true whether we regard the bizarre appearance of their skulls, their dentition, so weak when compared with the bulk of their bodies, or the insignificant size of their brain. We only know them as yet from the Bridger or Upper Eocene formation of North America, with a species possibly from the Wasatch or Lower Eocene.

The characters of this suborder have been already pointed out (Vol. XVIII, p. 1121). The differences from the Pantodonta are well marked, but the resemblances are such as to render it impossible to refer the Dinocerata to a different order. Their strong resemblances to the Proboscidia are generally admitted, but the few characters which distinguish them are of the first importance. These are, first, the very small size of the brain, especially of the cerebral hemispheres; and second, the double distal articulation of the astragalus, where the facet for the cuboid bone is nearly as large as that for the navicular.

Within the above definition there is room for much variation, which, however, the known genera do not display. They agree in various points of minor importance. Thus there is no sagittal

crest of the skull, the temporal ridges being lateral, and there is a great transverse supraoccipital crest. These crests are more or less furnished with osseous processes or horns. The middle pair of these (Fig. 29) consists in part of the maxillary bone, and stands in front of or over the eye. The nostrils are well roofed

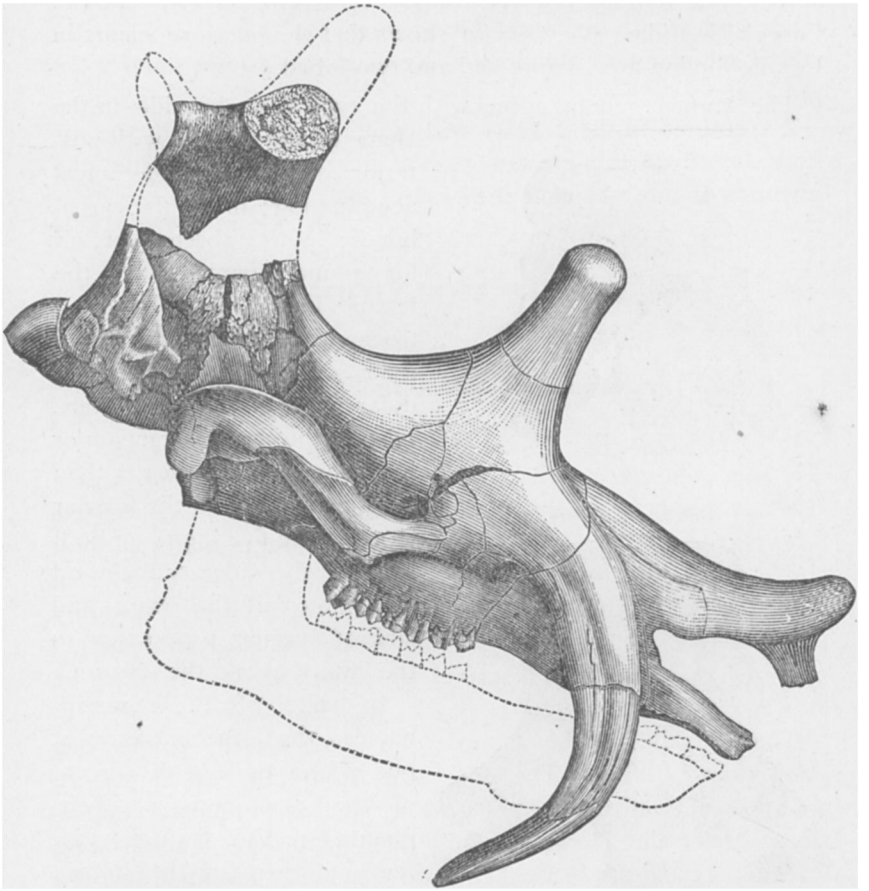


FIG. 24.—*Loxolophodon cornutus* Cope, skull from right side, one-eighth natural size. From the Bridger bed of Wyoming. Original, from Report U. S. Geol. Survey Terrs., F. V. Hayden, Vol. III. Lower jaw restored from Osborn, Memoir on Loxolophodon and Uintatherium. From individual represented in Pl. I.

over by the nasal bones. There is always a diastema behind the canine tooth in both jaws. There is less difference between the premolar and molar teeth in the known genera than in the Pantodonta, and they all have the same pattern, although the origin of the pattern may be different in the two series. Thus in the upper

jaw the crowns of the molars support two oblique cross-crests, which unite to form a V with the apex inwards. There is sometimes an internal cusp or tubercle. The inferior molars consist essentially of an outer V and a heel; the true molars differ in having the heel a little larger and more recurved on its posterior border, but it does not rise into a transverse crest as in the Coryphodontidæ. Mr. Osborn shows that the inferior incisors in Loxolophodon are compressed and two-lobed.

The known genera agree with the typical Proboscidia in the shape of the scapula with posterior expansion and apical acumination; in the flat carpal bones; in the absence of pit for round ligament of the femur; in the flattened great trochanter, contracted condyles, and fissure-like intercondylar fossa of the same bone. Also in the short calcaneum or heel bone, which is wider than long, and rough on the inferior face; in the five digits on both feet, and the wide peduncle and iliac plates of the pelvis and lack of angular production of the latter beyond the sacrum.

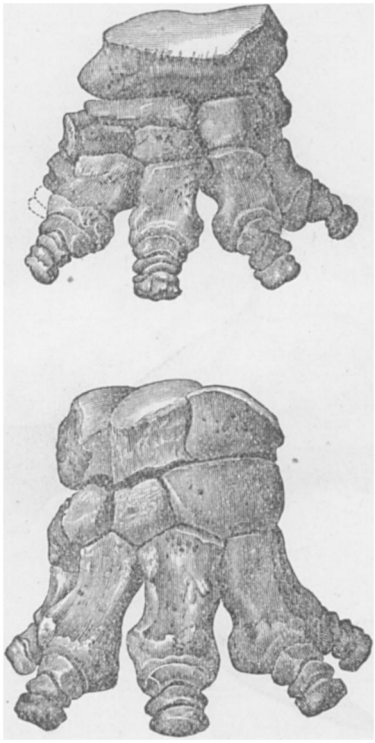


FIG. 25.—*Uintatherium mirabile* Marsh, bones of feet, two-ninths natural size. Upper figure anterior, lower figure posterior feet. From Bridger beds of Wyoming. Slightly altered (lunar bone) from Marsh, *Am. Journ. Sci. Arts*, XI, Pl. VI.

In spite of these resemblances, the Dinocerata are at one side of the line of descent of the mastodons and elephants (see Vol. XVIII, p. 1121, for phylogeny of the hoofed Mammalia). This is indicated not only by the structure of their feet, but by that of their teeth, which, as I have shown, constitute a survival of the tritubercular type which had been left behind by all other cotemporary ungulates, and only survived in the flesh-eaters of the Bridger epoch.

The resemblance of the feet to those of Coryphodon may be readily seen by comparing Fig. 25 with Figs. 1–2 (p. 1110, Vol. XVIII). The characters of the component parts are quite identical.

Professor Marsh has given us a figure of the cast of the brain chamber of the *Uintatherium mirabile* Marsh. It displays most striking peculiarities. These are: (1) The small size of the hemispheres; (2) the difficulty of distinguishing the cerebellum from the surrounding parts; (3) the large size of the olfactory lobes (Fig. 26). In all these respects there is a great resemblance to the brain of Coryphodon (Fig. 13). The hemispheres pass into the olfactory lobes by a gradual contraction of their outlines. They rise higher than, and then descend posteriorly towards the mesencephalon and cerebellum. The latter parts, as in Coryphodon, are not distinguished in the cast. The hemispheres are not convoluted, nor is there any sylvian fissure, according to Marsh's figures. This brain, as remarked by Marsh, is the most reptilian among the Mammalia. One of the strongest confirmations of this statement, is the small size of the cerebellum.

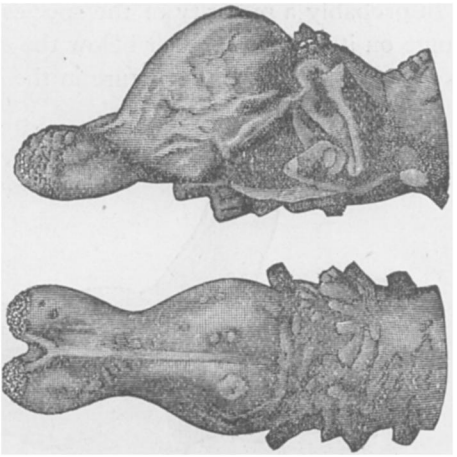


FIG. 26.—*Uintatherium mirabile* Marsh, brain one-third nat. size. From Marsh, *Amer. Jour. Sci. Arts*, Vol. XI, Pl. IV.

Owing to the imperfect character of the material which I have had the opportunity of examining, it is not possible to state the number of genera with absolute certainty. There are certainly three of these, and probably four. So far as present knowledge goes, they pertain to one family, which I have called the Eobasiliidæ. The three genera mentioned differ in the forms of the mandible; the fourth has certain cervical vertebræ of a peculiar form, but the form of the mandible is unknown. I can only contrast the genera as follows:

A. Mandible unknown.

Certain cervical vertebræ short and flat, as in Proboscidia ..... *Eobasileus.*

AA. Symphysis of mandible with four teeth on each side.

a. Mandible without inferior expansion.

Cervical vertebræ not very short; three premolars; lower incisors bilobate, *Loxolophodon.*

aa. Mandible with anterior inferior expansion.

Cervical vertebræ not short; three premolars..... *Octotomus.*

aaa. Mandible expanded below, its entire length.

Cervical vertebræ unknown; four lower premolars; four incisors, simple, *Bathyopsis.*

AAA. Symphysis of mandible with three or two teeth on each side.

Mandible with very narrow symphysis..... *Uintatherium.*

In probably a majority of the species the lower jaw has a deep flange on its inferior border below the canine teeth, which serves, like the corresponding structure in the saber-tooth tigers, to pro-

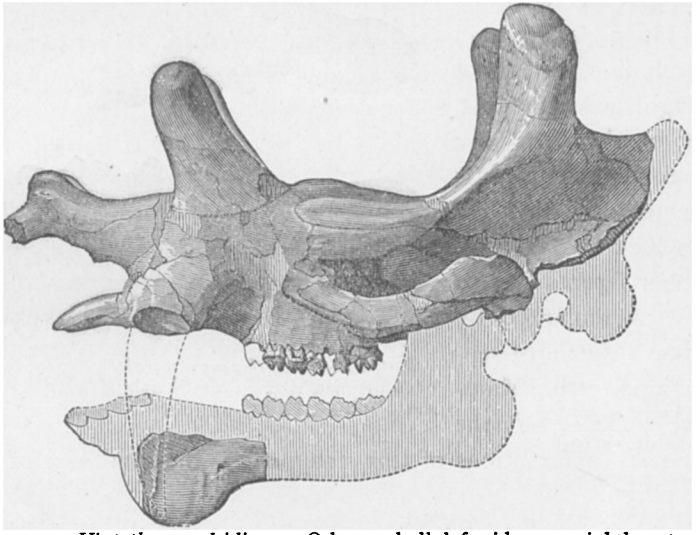


FIG. 27.—*Uintatherium leidianum* Osborn, skull left side, one-eighth nat. size; rom the Bridger beds of Wyoming. From Osborn, Memoir on Loxolophodon and Uintatherium.

tect the long superior canine tooth from lateral blows and strains (Fig. 27). In Bathyopsis this inferior expansion includes almost the entire inferior border of the ramus, giving an outline something like that of Megatherium (Fig. 35).

The genus Eobasileus was established on a species (*E. pressicornis* Cope) which is represented by a considerable part of the

skeleton, but without cranium or teeth; hence most of its characters remain unknown. The very short cervical vertebra which belongs to it serves to distinguish it from other genera. A second specimen (*E. furcatus*) found near the first, may belong to it; it includes a fragmentary cranium, but unfortunately no cervical vertebræ. Its introduction into this genus is therefore purely arbitrary.

The typical species is of large proportions, only second in size to the *Loxolophodon cornutus*. Its limbs were more slender in their proportions. It is in this species that I find much evidence in favor of the presence of a proboscis of greater or less length. Should several of the other cervical vertebræ have been as short as the one preserved, it is evident that the animal could not possibly have reached the ground with a muzzle so elevated as the long legs clearly indicate. In the species of the other genera, where the cervical vertebræ are longer, this may have not been the case.

The bones of this species were discovered by the writer in an amphitheater of the bad lands of the Washakie basin, known as the Mammoth buttes, in Southwestern Wyoming. They were in greater or less part exposed, lying on a table-like mass of soft Eocene sandstone. A description of this remarkable locality is given in the *Penn Monthly Magazine* for August, 1872.

The *Eobasileus furcatus* is principally represented by a skull in which the most important features have been preserved. As in all the species of Uintatherium in which the horns are known, these appendages stood in front of the orbits, it is probable that such was the case in the *Eobasileus furcatus* also. The muzzle is materially shorter and more contracted, and the true apex of the muzzle was not overhung by the great cornices seen in *Loxolophodon cornutus*. The occipital and parietal crests are much more extended in this species than in the *L. cornutus*, so that in life the snout and muzzle had not such a preponderance of proportion as in that species. All the species of this genus were rather rhinocerotic in the proportions of the head, although the horns and tusks produced a different physiognomy.

The known species of Loxolophodon Cope, are the largest of the order. Three species are known to be distinct: the *L. cornutus* Cope, *L. galeatus* Cope, and *L. spierianus* Osborn. They differ in the form of the horns and in the shape of the occiput.

The cranium in this genus is elongated and compressed. The muzzle is posteriorly roof-shaped, but is anteriorly concave and flattened out into a bilobed protuberance which rises above the extremity of the nasal bone. This extremity is subconic and short and decurved. A second pair of horn-cores stands above the orbits, each one composed externally of the maxillary bone, and internally of an upward extension of the posterior part of the nasal. Behind this horn the superior margin of the temporal fossa sinks, but rises again at its posterior portion, ascending above the level of the middle of the parietal bones. The occipital rises in a wall upwards from the foramen-magnum and supports, a little in front of the junction with the superior and posterior crests bounding the temporal fossa, a third horn-core on each side.

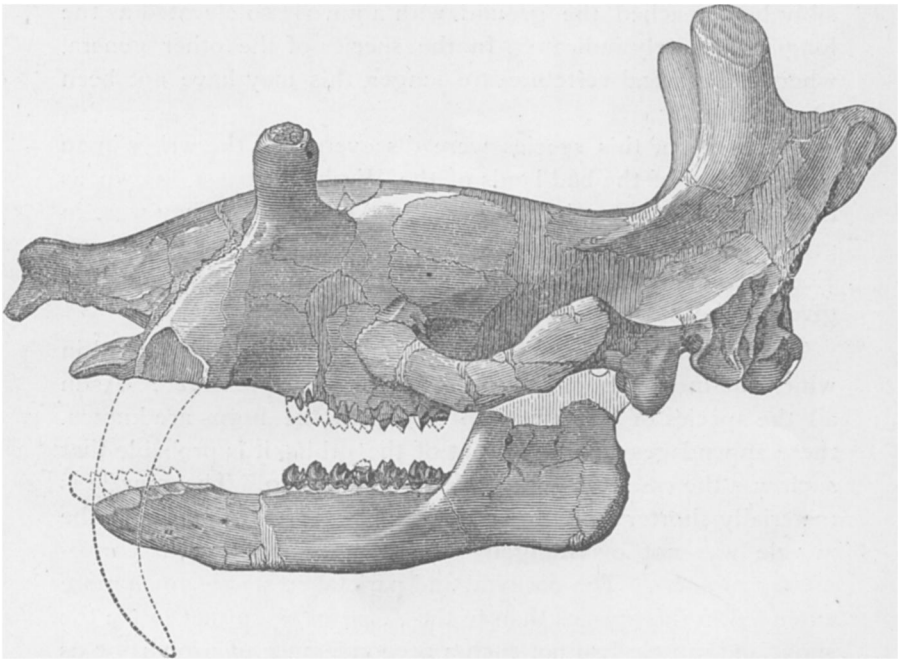


FIG. 28.—*Loxolophodon spierianus* Osborn, skull from left side, one-eighth natural size; from the Bridger beds of Wyoming. From Osborn, Memoir or Loxolophodon, etc.

The three species may be distinguished as follows:

Median horns triangular in section, with internal tuberosity, and above orbits; occiput narrow.....*L. cornutus.*
Median horns subquadrate in section without internal tuberosity; occiput and nasal tubercles wide.....*L. galeatus.*
Median horns subround and without tuberosity, in front or orbits; occiput and nasal tubercles narrow.....*L. spierianus.*

The *Loxolophodon spierianus* Osborn, was as large an animal as the two others, and had a very elongate skull with weak horns and narrow, high occiput. Its median horns are situated well anterior to the orbit, and its zygomatic fossa is remarkably small. It was discovered by the Princeton scientific exploring party at the same locality that produced the other species, viz., the Mammoth buttes of Southwestern Wyoming (Fig. 28).

In the *L. cornutus* and *L. galcatus* the tuberosities which stand

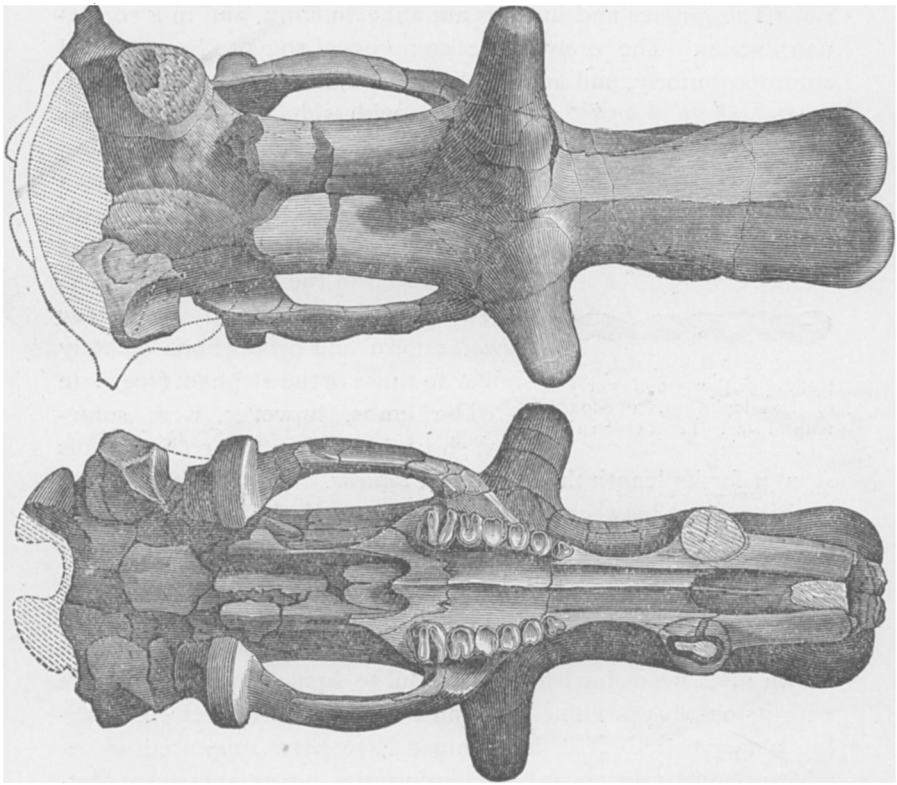


FIG. 29.—*Loxolophodon cornutus* Cope, skull of individual represented in Plate I, one-eighth nat. size. Upper figure superior surface; lower figure inferior surface. From Bridger Eocene of Wyoming. Original, from Report U. S. Geol. Survey of Terrs., F. V. Hayden in charge, Vol. III. Owing to distortion of the specimen behind, the occipital condyles are too far apart in the figure.

near the free extremity of the nasal bones are greatly developed, so as to represent a pair of cornices projecting upwards and forwards over the narrow apex of the bones (Fig. 24). From above, the end of the muzzle in those species has a bilobate outline. They differ from each other materially in the form of the middle pair of horns.

Mr. Osborn, of Princeton, has published a description of the lower jaw and teeth of a species of Loxolophodon, which he identifies with the *L. cornutus*, which was derived from the locality and horizon of the species above mentioned (Fig. 8). They show that the descending flange of Uintatherium and Bathyopsis is only represented by a convex ridge on each side of the symphysis. They point out the characters of the dentition, which are remarkable. The molars much resemble those of Bathyopsis. The canines and incisors are alike in form, and in a continuous series. The crowns are compressed so as to be extended anteroposteriorly, and are deeply emarginate, so as to be bilobed, the lobes with subacute edges. This form of incisors is unique, resembling only remotely the large median incisors of certain Insectivora (Fig. 30). Resemblance to mammals of the same type may be traced in the molar teeth.

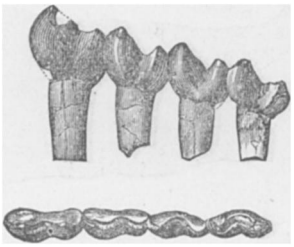
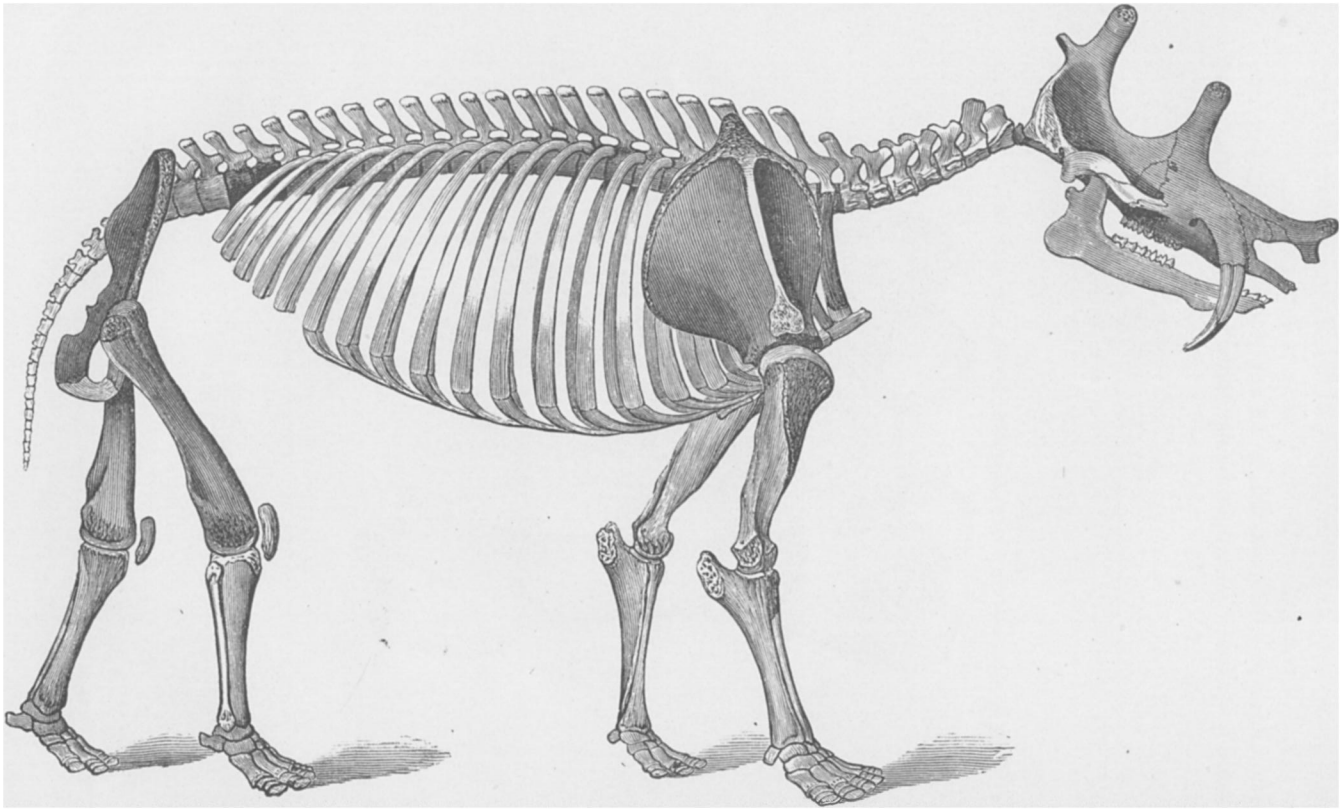


FIG. 30.—Incisor and canine teeth of left side of lower jaw of Loxolophodon, one-fourth natural size. From Osborn.

We may ascribe to the *Loxolophodon cornutus* form and proportions of body similar to those of the elephant (see Plate I). The limbs, however, were somewhat shorter, as the femur (Fig. 31) is stouter for its length than in the *E. indicus*. It was intermediate in this respect between the latter species and the species of Rhinoceros. The tibia is relatively still shorter. The tail was quite small. The neck was a little longer than in the elephants, but much less than in the rhinoceroses; the occipital crest gave attachments to the *ligamentum nuchæ* and muscles of the neck, which must needs have been powerful to support the long muzzle with its osseous prominences, and to handle with effect the terrible laniary tusks. The head must have been supported somewhat obliquely downward, presenting the horns somewhat forward as well as upward. The third or posterior pair of horns towered above the middle ones, extending vertically with a divergence when the head was at rest. The posterior and middle pair of horns were no doubt covered by integument in some shape, but whether dermal or corneous is uncertain. Their penetrating foramina are smaller than in the Bovidæ. The cores have remotely the form of those of the *Antilocapra americana*, whence I suspect that the horns had an inner process or angle as in the



Loxolophodon cornutus Cope, restored to $\frac{1}{17}$ nat. size. The darkly shaded portions are those in my possession; the feet and caudal and cervical vertebræ are restored after Marsh (Uintatherium); the lower jaw after Osborn. Original, from AMERICAN NATURALIST, 1882, p. 1029.

prong-horn at present inhabiting the same region. The nasal shovels may have supported a pair of flat divergent dermal tuberosities, but this is uncertain; they are not very rugose.

The elevation of the animal at the rump was about six feet, distributed as follows, allowance being made for the obliquity of the foot:

	Inches.
Foot	4.50
Tibia	20.50
Femur	31.75
Pelvis	16.00
	72.75

The anterior limbs were stouter than the posterior, judging

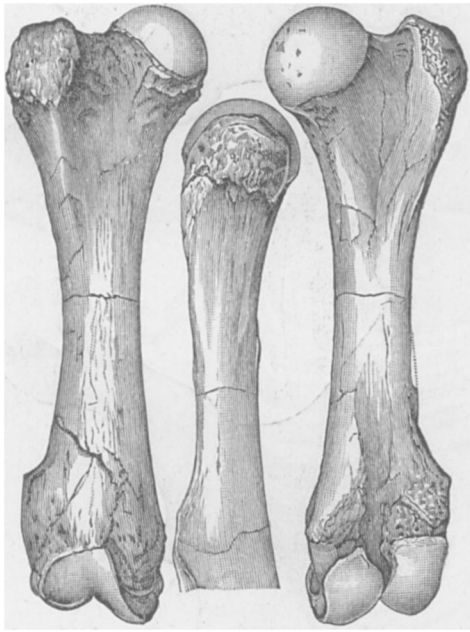


FIG. 31.—*Loxolophodon cornutus* Cope, femur of individual represented in Pl. I, one-ninth nat. size. From Bridger beds of Wyoming. Original, from Report U. S. Geol. Surv. Terrs., III, F. V. Hayden in charge.

from the proportions in various species, and were no doubt longer if of the Proboscidian character. This would give us the hypothetical elevation at the withers:

	Inches.
Leg	61.00
Scapula (actual)	21.00
Neural spines (extremities)	7.00
Or 7 feet 5 inches	89.00

These measurements are made from the plantar and palmar surfaces, allowance being made for the pads.

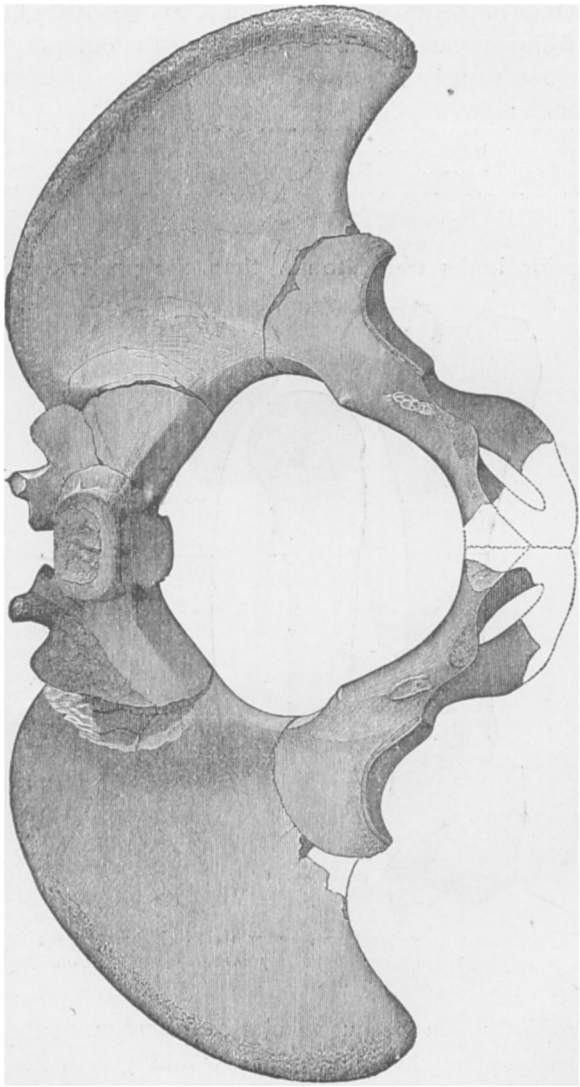


FIG. 32.—*Loxolophodon cornutus* Cope, pelvis of individual represented in Pl. I; from front; one-eighth nat. size. Original.

The obliquity of the anteroposterior axis of the anterior dorsal vertebra indicates that the head was posteriorly elevated above the axis of the dorsal vertebræ. Owing to the lack of cervical ver-

tebræ, the length of the neck cannot be determined. It may have been short, as in the *Eobasileus pressicornis*, or longer, as in the species of Uintatherium. The indications derived from the bones of the muzzle point to the attachment of a heavy upper lip. The numerous rugosities of the posttympanic and mastoid regions indicate the insertions of strong muscles. Some of these may have been adductors of large external ears.

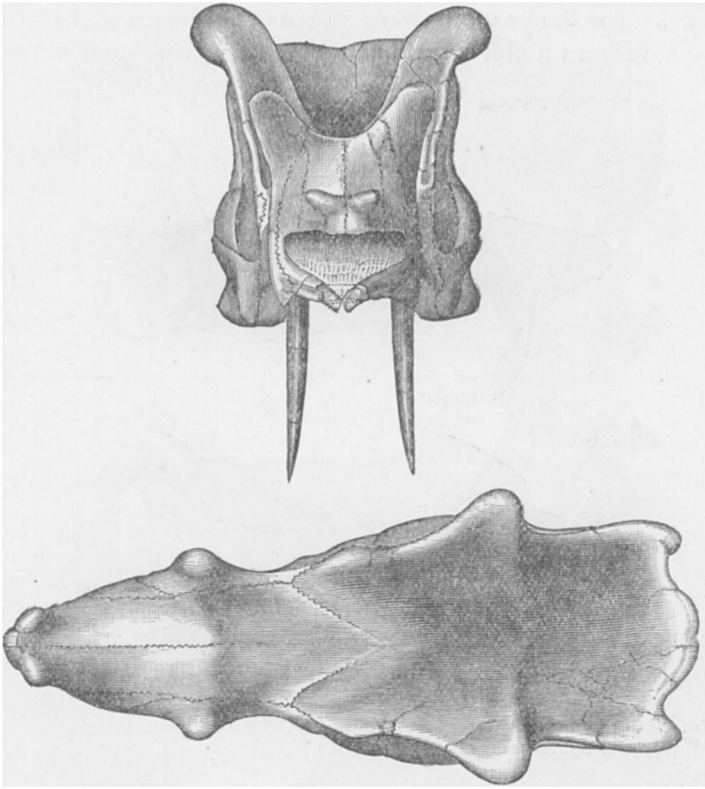


FIG. 33.—*Uintatherium mirabile* Marsh, skull, one-eighth nat. size; upper figure from front, lower figure from above. From Bridger Eocene of Wyoming. From Marsh, *Amer. Jour. Sci. Arts*, XI, Pl. II.

The inferior incisor teeth have no adaptation for cutting off vegetation. The mental foramen is small, but the small nutrient artery thus indicated is not adverse to belief in a prehensile under lip to make up for the uselessness of the teeth. The projecting nasal regions would prevent short lips from touching the ground.

The posterior position of the molar teeth indicates use for a long, slender tongue.

This species was probably quite as large as the Indian elephant, for the individual described is not adult, as indicated by the freedom of the epiphyses of the lumbar vertebræ; and fragments of others in my possession indicate considerably larger size.

The very weak dentition indicates soft food, no doubt of a vegetable character, of what particular kind it is not easy to divine. The long canines were no doubt for defence chiefly, and may have been useful in pulling and cutting vines and branches

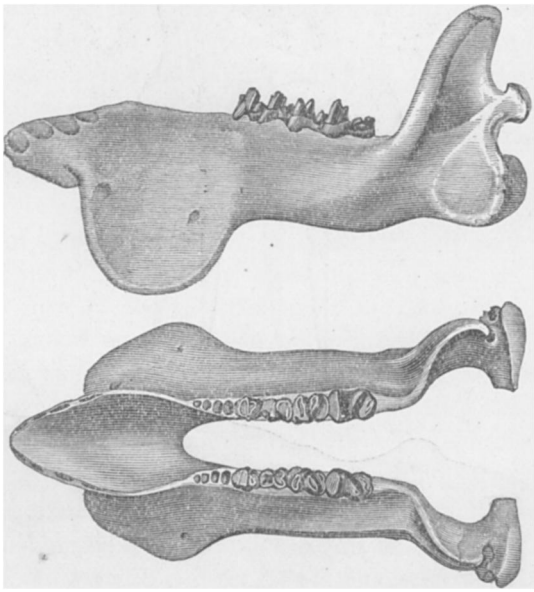


FIG. 34.—*Octotomus laticeps* Marsh, lower jaw, one-eighth nat. size; upper figure left side, lower figure from above. From Marsh, *Amer. Jour. Sci. Arts*, XI, Pl. V.

of the forest. The horns furnished formidable weapons of defence. The anterior nasal pair might have been used for rooting in the earth, if the elevation of the head did not render this impossible.

This huge animal must have been of defective vision, for the orbits have no distinctive outline, and the eyes were so overhung by the horns and cranial walls as to have been able to see but little upward. The muzzle and cranial crests have obstructed the

view both forward and backward, so that this beast probably resembled the rhinoceros in the ease with which it might have been avoided when in pursuit.

The genus Uintatherium Leidy, has the symphysis of the mandible more contracted than in the other genera, and the number of its teeth correspondingly reduced.[1] The type is the *U. robustum* Leidy, a species which is known from the posterior part of a skull with a few molar teeth of both jaws, and a superior canine tooth of one individual; and by the greater part of the lower jaw of another. It is of smaller size than those referred to Loxolophodon, and also smaller than the *U. leidianum* Osb. (Fig. 27). Besides these two species four others have been described by Marsh and referred to a genus Dinoceras, which is not yet known to be distinct from Uintatherium. The best known of these is the *U. mirabile* (Figs. 25, 26, 33), which has been well figured by Marsh. It lacks a tubercle of the last superior molar which is present in the *U. robustum*. Its lower jaw is unfortunately unknown. A species described by Marsh as *Dinoceras laticeps* is of larger size than the *D. robustum*, and Marsh figures its lower jaw (Fig. 34). It possesses four teeth on each side of the symphysis, as in Loxolophodon, but their form is not known. There is a deep flange of the lower edge of the ramus below the canine teeth, as in Uintatherium. As this form represents a genus clearly distinct from either of these, or Bathyopsis, I propose that it be called Octotomus. To this genus may belong some of the species now provisionally referred to Uintatherium.

In these animals the nasal tuberosities are small, and do not overhang the apex of the nasal bones. The median horns are anterior to the orbits, and are of various degrees of development in the different species. The posterior horns vary in like manner (compare Figs. 27 and 33). The supraoccipital crest extends much further posteriorly in the *U. mirabile* than in some of the other species.

In the genus Bathyopsis Cope, not only the incisors and canines, but also the molars are of the full number, *i. e.*, I. $\frac{3}{3}$; C. $\frac{1}{1}$; Pm. $\frac{4}{4}$; M. $\frac{3}{3}$. This, with the posteriorly extended expansion of the ramus of the lower jaw, distinguishes it from the other genera. But one species is known, the *B. fissidens* Cope, which

[1] See Cope, Proceeds. Academy Philadelphia, 1883, p. 295.

was an animal probably as large as the Javan rhinoceros (*Rhinocerus sondaïcus*), or rather smaller than the *Uintatherium robustum.*

The characters of the inferior molars in this and other genera of Dinocerata are very peculiar. In Bathyopsis they are constructed on the plan of those of insectivorous marsupial and placental mammals, so as to lead to the suspicion that its food consisted of Crustacea, or insects of large size, or possibly of thin-shelled Mollusca.

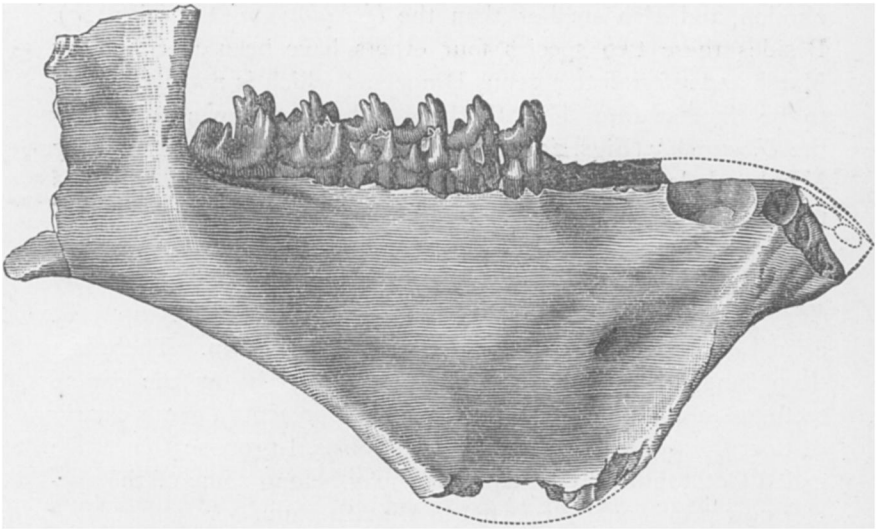


FIG. 35.—*Bathyopsis fissidens* Cope, mandible from right side, four-ninths nat. size. Specimen represented in Fig. 7. From the Wind River (Bridger) bed of Wyoming. Original, from Vol. III, U. S. Geol. Survey Terrs., F. V. Hayden.

The form of the ridges of the anterior part of the jaw of the *Bathyopsis fissidens*, together with the remarkably large dental canal and mental foramen strongly suggest that the animal possessed a large and perhaps prehensile lower lip. The lateral descending crests of the lower jaw must have affected the physiognomy curiously, especially when viewed from the front.

In the history of the discovery of the various types of the Amblypoda, we have an illustration of the prevision which the palæontologist may exercise as a legitimate inference from known facts. In closing his memoir on these animals (p. 44) Mr. Osborn remarks: "In the Upper Cretaceous or early Eocene lived a

group of animals which were the common ancestors of the Dinocerata and Pantodonta." This was written and published in 1881. In the following year, 1882, I discovered the Pantolambdidæ in the lowest Eocene bed known in America. How well this family fulfills the anticipations of Mr. Osborn may be seen by reference to the earlier pages of this essay on the Amblypoda (see NATURALIST, Vol. XVIII, p. 1111).

The tracing of the phylogeny of the Amblypoda from its earliest to its latest representatives, has presented us with an interesting chapter in brain evolution. It has been asserted[1] by Lartet, and repeated by Marsh, that there has been a continuous progress in the increase in the size and complexity of the brain in the Vertebrata, with the passage of geological time. This principle, as a whole, is confirmed by the results of my own studies. The Amblypoda constitute the sole exception known to me. The brain of the *Pantolambda bathmodon*, though of the same type as other Amblypoda, is relatively much larger than in its descendants of the Dinocerata and Pantodonta. It is a clear case of retrogression, and not of progression, in brain development.

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EDITORS' TABLE.

EDITORS: A. S. PACKARD AND E. D. COPE.

—— The Presbyterian denomination, from the nature of its theology, is more disposed to critical and exact study than some of the other bodies of Christians. The relations of the doctrine of the evolution of species, and of the mental phenomena they display, to the prevalent theologies, are obvious. Not that it is necessary that teachers of righteousness should know all about the creation, but theology must have something to say on the subject. The discussion of these questions by Presbyterian ministers naturally produces a wider-spread agitation than in the case of Congregationalists, on account of the difference between the two churches in their system of organization, which does not give that independence to the congregation in the former that is possible in the latter. Thus while Mr. Beecher's advocacy of the evolution of man and its logical consequences, has not affected his standing in his church, when Dr. Woodrow, of the theologi-

[1] *Comptes Rendus*, June, 1868.